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THE CALIFORNIA SEA LION CENSUS FOR 1947[1]

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At the beginning of the last century great herds of sea lions lived along the California coast. A local race of fur seals, and a species of sea elephants inhabited the southern half of the coastal area. The fur of the fur seals and the oil from the sea lions and sea elephants found a ready market. The seal hunters pursued them with a methodical persistence that practically exterminated the fur seals and sea elephants, and reduced the sea lion herds so drastically that it was no longer profitable to hunt them. By the end of the century the seal hunters had moved on to greener fields, or had taken up commercial fishing.

In the last 20 years commercial fishing along the California coast has grown tremendously. Canneries and reduction plants have increased in number and capacity. Fishing boats and gear have followed suit. The 20-foot boats, that landed 500 pounds of fish taken in a local area, have been replaced by ocean-going purse seiners that deliver 200 tons.

Figure 25. Steller Sea Lions, Ano Nuevo Rookery. Photograph by Wm. E. Ripley, June 27, 1947

Because of recurring complaints of damage by sea lions, a number of surveys have been made to determine the size of the population, and to determine, if possible, what the animals eat, and the amount of damage they actually do.

[1] Submitted for publication February, 1948. We take pleasure in acknowledging our indebtedness to the officers and men of the United States Navy, Blimp Squadron One, based at Moffett Field and Santa Ana, California, for the cooperation and assistance given us in making this survey.

Table I gives the population for the years in which surveys have been undertaken. The census is taken during June or July, the middle of the breeding season, at which time the animals are concentrated on their rookeries. At other times of the year they are scattered along the entire coast. The Steller bulls are not numerous in California during the winter. They appear to move up the coast to British Columbia and southern Alaska. The Californias may also evince a northward movement during the winter, some Lower California animals migrating to southern California.

Sea lions seem to have a more catholic taste in the matter of diet than most carnivorous animals. They eat any fish, mollusc, or crustacean that is locally plentiful and easily caught. At times they are a definite nuisance to fishermen. They frighten and scatter schools of fish, and damage nets and gear. However their numbers, their consumption of fish and the damage to fishing gear attributed to them are usually exaggerated by fishermen. Despite the avowed depredations of the sea lions, the commercial fisherman of California manage to deliver, in an average season, over a billion pounds of fish.

During the last two seasons, an innovation in the method of taking the sea lion census has been introduced with the use of planes and blimps. This technique has improved the accuracy of the census. Several rookeries were studied and photographed which previously could not be accurately estimated as it was not possible to approach them either from the land or by boat. The whole coast line and the outlying islands can be examined in two or three days instead of the two or three weeks previously required, and comprehensive photographs can be more readily obtained. On enlarged photographs it is possible to count the animals accurately. It has been found that estimates of the number of animals, by experienced observers, are within 5 percent of the numbers actually counted on the photographs.

In 1946 the census was compiled from the counts and estimates of a number of individuals. The 1946 report employs a different manner of presentation than that used in previous reports, and is therefore not comparable with them. The totals for 1946 are given at the bottom of Table I. The 1939 report is based on estimates made in March, and includes only about half the rookeries (Fry, 1939). It cannot therefore be logically compared with other seasons.

In 1947 two experienced observers surveyed the entire coast line. Due to unavoidable mishaps, photographs of some five rookeries were unsatisfactory, or were not obtained; but all rookeries, with the exception of San Nicolas Island, which was checked by the crew of a boat of the Bureau of Patrol, were observed. Where satisfactory photographs were obtained, the estimates check within 5 percent; so it may be assumed that the estimates not verified by photographic counts will be within that tolerance.

The total population of both species of sea lions on the California coast in 1947 was found to be 8,716.

In the last 20 years the sea lion population has remained fairly stable. The average for the five previous surveys is a little over 7,000. The increase in 1947 may be the result of the more rapid and comprehensive coverage of the coast by air, which permits the detection and inclusion of individuals and small groups in out-of-the-way and isolated parts of the coast.

TABLE I. NUMERICAL COMPARISON OF THE SEA LION POPULATION OF THE COAST OF CALIFORNIA*

	1927		1928		1930		1936		1938		1947	
	Steller	California	Steller	California	Steller	California	Steller	California	Steller	California	Steller	California
St. George Reef	1,500		611		700		652		325		200	
Turtle Rocks	200		200				100		93			
Cape Mendocino	700		700		900		700		500		625	
Punta Gorda											40	
Point Arena	300		206		300		142					
Fort Ross											100	
Point Reyes							45	9	6		2	
Farallones	700	6	540		900	28	500	25	357	90	750	
Purissima	150		42				4		2		50	
Ano Nuevo	1,500		1,500		2,500		1,000	200	2,000		2,050	
Bird Rock							25	250	53	1	3	
Cypress Point									1	15	10	
Point Lobos			200	70	49	160	60	3	120	1	390	
Cape San Martin			50					20				
Piedras Blancas	212	86	100	1	34	23	6	35	73	21	400	
Lion Rock	86	21		6			60	20	243	10	78	
Pecho Rock	135	7	95	75	300		70		3	3	18	
Point Sal		10					75	150	35	25		340
Point Arguello				10			50	20	2			
San Miguel Island	595	149	592	429	620	205	1,359	520	1,992	714	950	650
Sandy Point	49		38		12		52		20			
Frazer Point	2	63		88	40	95			15	25		30
Gull Island	18	150	10	105	5	68		200		25		70
Cochies Point									1	75		
Anacapa Island		34		27		11		11		10		
St. Barbara Island		125		327		8		600		500		1,000
San Nicolas												660
Castle Rock		29		23		7		35		15		
Seal Harbor	1	235		228		340		400		475		
South of Seal Harbor												250
Santa Catalina										15		20
San Mateo Rocks												30
Totals	6,148	915	4,884	1,389	6,360	945	4,900	2,498	5,841	2,020	5,666	3,050
Totals (Both Species)		7,063		6,273		7,305		7,398		7,861		8,716

The groupings in 1946 are by areas rather than by rookeries, and are therefore not comparable to other years.

1946 Census: No. California (Steller) ---------- 5,168
So. California (Calif.) ---------- 7,338
12,506

* The two species represented are steller's sea lion *(Eumetopias jubata)*, and the California sea lion *(Zalophus californianus)*.

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A CONTRIBUTION TO THE LIFE HISTORY OF THE SACRAMENTO PERCH *(ARCHOPLITES INTERRUPTUS)* IN CLEAR LAKE, LAKE COUNTY, CALIFORNIA[1]

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Introduction

In the course of investigations on Clear Lake a limited amount of data relative to the Sacramento Perch *(Archoplites interruptus)* was obtained. Since little information is available on this centrarchid, the only native member of the sunfish family west of the Rockies, it is believed that any observation is a contribution.

Clear Lake is a large lowland lake of 40,000 surface acres, located in the Upper Sonoran Life Zone of central Northern California. It is a part of the Sacramento-San Joaquin drainage basin, being connected by its outlet, Cache Creek, with the Sacramento River via the Yolo By-pass.

The Sacramento Perch is restricted to the Sacramento-San Joaquin drainage and the smaller neighboring Pajaro River system. Before the introduction of alien species, the Sacramento Perch was exceedingly abundant throughout the lowland areas. Its size was reported by Jordan and Evermann (1896-1900) as 12 to 24 inches. At the present time it is scarce except in isolated localities, one of which is Clear Lake.

General Information

The Sacramento Perch (Fig. 26) occupies a minor position in the sport catch of Clear Lake. In 1947, it constituted 1 percent of the total catch. Formerly, trout and the Sacramento Perch were the only game fish to be found in the lake. Since then introduced sunfish, bass, and catfish, and changing ecological conditions, have reduced the numbers of this species. In 1947 the catch of Sacramento Perch was made in April, May, and June only, a period that corresponds roughly with prespawning and spawning concentrations. The only explanation for their disappearance after this date is that they must range the entire lake after spawning. Since their numbers are small, the chances of their being captured by offshore anglers are small.

No studies of the food habits of the Sacramento Perch were made. However, by inference, a rough pattern emerges. Young of the year are found in association with bluegill *(Lepomis macrochirus)* in the littoral zone, where they probably feed on larger zooplanktons and insects. Adults are captured on spinners and live minnows, but almost never on worms, so it can be assumed that after reaching a certain size they become at least partially piscivorous. Lindquist, Deonier, and Hancey (1943)

[1] Submitted for publication March, 1948.

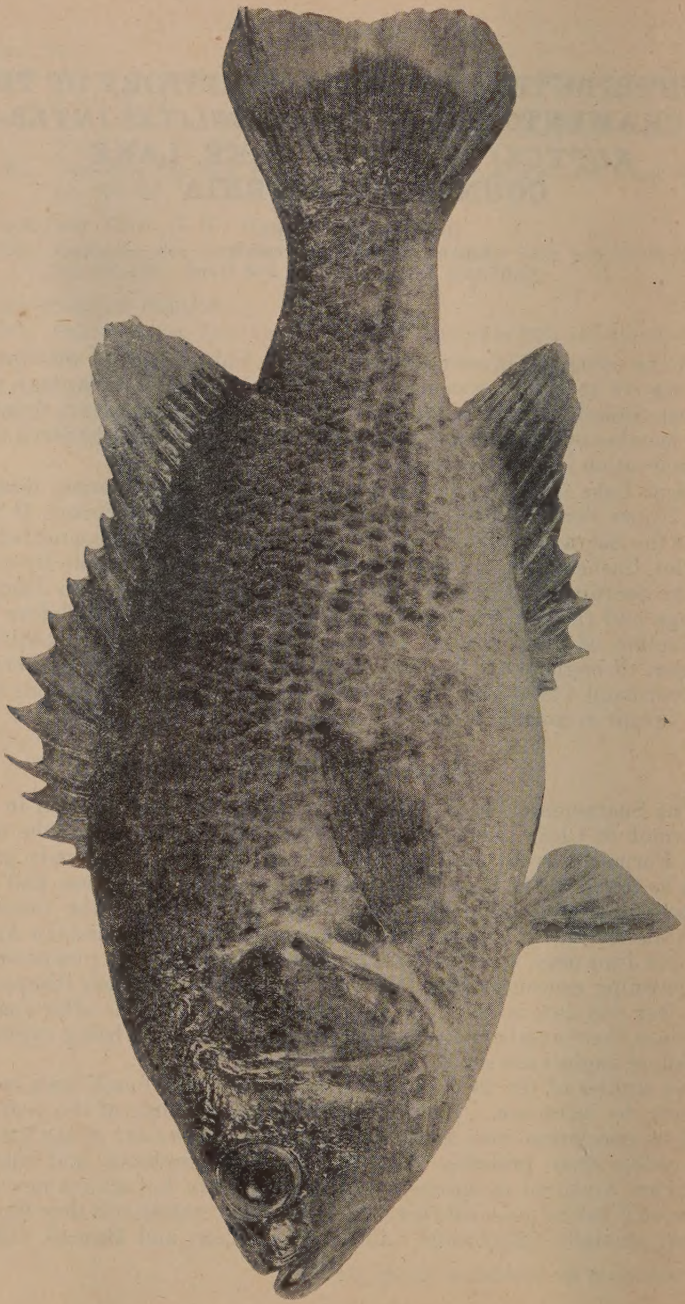

FIGURE 26. Sacramento Perch, *Archoplites interruptus*

found the specimens they examined had fed on all stages of the phantom midge *(Chaoborus astictopus)*, which is distributed over most of the offshore section of Clear Lake. The young of the native cyprinids, such as the Sacramento Hitch *(Lavinia e. exilicauda)* move into the offshore areas during the middle of the summer, affording a supply of forage fish to the perch.

Spawning Habits

A school of spawning Sacramento Perch was observed on June 15, 1947, off Austins Pier near Lower Lake. No spawning fish were in the area on June 14th and none on June 16th. According to the boatman, Mr. Jess Loomis, spawning activity commenced about 9 a.m. on June 15th. The writer began observations at 12 noon.

An estimated 50 adult fish were spawning in an area 12 feet long and four feet wide. The spawning ground adjointed a rock breakwater. The water depth varied from one to two feet and the temperature was 75.5 degrees Fahrenheit. The substrate consisted of boulders from three inches to one foot in diameter, covered by a heavy growth of algae. A few straggly growths of pond weed, *Potamogeton,* occurred in the area. As seen from above, the fish were paired, although some exchange of mates appeared to take place. The spawning activity of each pair was roughly cyclic. Activity would commence by general restlessness of the pair, accompanied by considerbale nudging and butting. Egg deposition followed and was accomplished in a few seconds with the vents in close approximation. During deposition both fish were tense, the female with mouth agape, and both fish often in a vertical position, with either the heads or the tails up. Deposition was followed by more predeposition activity, more deposition, and finally by a rest period of about five minutes, during which any intruder was ejected from the pair's deposition area. During the rest period the female would occasionally stray from the deposition area while the male remained on guard. (The term "deposition area" is used, since each pair spawned in a definite area about 1.5 feet in diameter, although no nest-building activity of any sort was observed.)

By 3 p.m. activity on the spawning ground had decreased markedly and comparatively few fish were in sight. Most of these were males guarding the deposition area. By 4 p.m. all fish had left the spawning ground.

Examination of the substrate showed that the adhesive eggs were attached directly to the heavy growth of algae on the rocks (Figure 27). A few were found on the *Potamogeton* and a few on bare rock. The vertical position assumed occasionally by the spawning fish may have been due to deposition on a vertical surface; considerable spawn was found on vertical surfaces, but it was impossible to tell if it was deposited while in the vertical position.

An abundance of the types of substrate on which most centrarchids spawn, such as gravels, existed nearby, but no Sacramento Perch were observed using them. The use of algae-covered rocks and plants as a substrate was one of choice.

During the height of spawning activity, it was almost impossible to disturb the fish. As the activity subsided, the females were the first to wander off. The males remained in the deposition areas for a short time, up to 30 minutes, apparently on the possibility of additional females

appearing, and then wandered off. During the late afternoon, after spawning had subsided considerably, the fish were very skittish, males and females leaving the area permanently at the slightest provocation. By 4 p.m. no fish were observed on the spawning ground.

On June 15th eggs were extremely abundant on the algae-covered rocks, in some cases forming a solid crust. On June 16th it was almost impossible to locate eggs. The few that were found were well along in development, with hearts beating, indicating that development is rapid, as in other centrarchids.

A female 10.5 inches long snagged off the spawning bed contained an estimated 84,000 unspawned mature eggs.

The first Sacramento Perch of the year were taken in Clear Lake on June 9, 1947, at an average length of 0.8 of an inch, which indicates that spawning had begun in May. By June 24th the majority had spawned, judging by the condition of the gonads of adults captured in nets. During the period May 19th to June 26th the water temperatures of Clear Lake at a depth of two feet varied from a maximum of 84 degrees F. to a

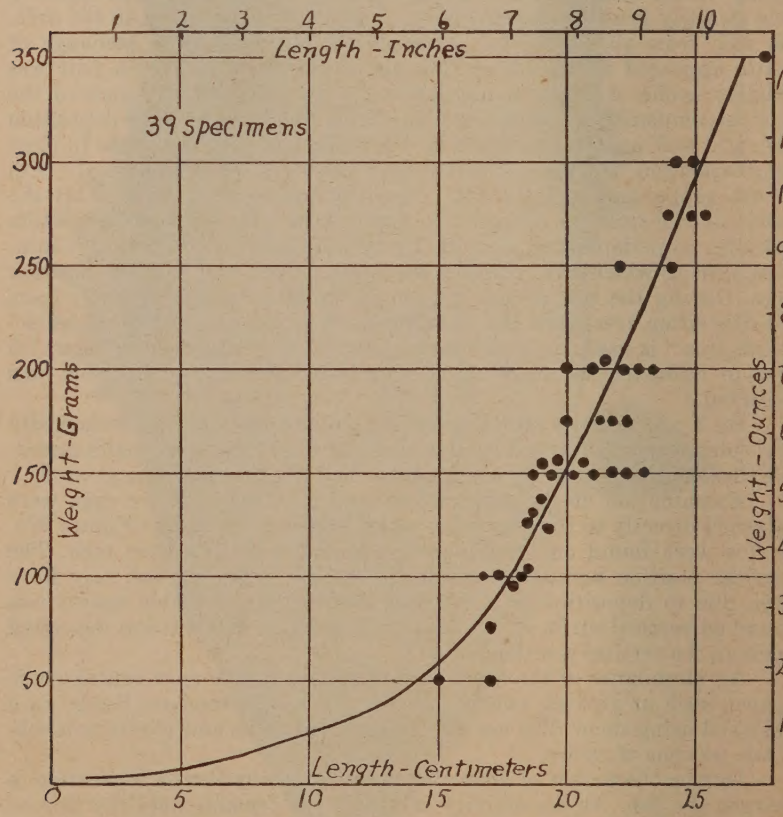

FIGURE 27. Length-weight relationship of Sacramento Perch, Clear Lake, 1946-1947. Curve fitted by eye.

minimum of 62 degrees F., as recorded from a maximum-minimum thermometer.

Sacramento Perch in Clear Lake spawn after their first year, judging by the samples collected.

Growth

It appears that after the young of the year reach a length of about two inches they abandon the immediate shoreline and range the open waters of the lake. Seine hauls on July 7th and August 7th took specimens 1.9 and 2.0 inches long respectively near shore. The length of the individuals in the shore population remains relatively constant, since the larger individuals move out of reach of small seines. The largest fish of the year taken in 1947 was 3.5 inches long, and was captured on October 11th in a fyke net set 120 yards off shore.

Figure 27 gives the length-weight relationship of Sacramento Perch in Clear Lake.

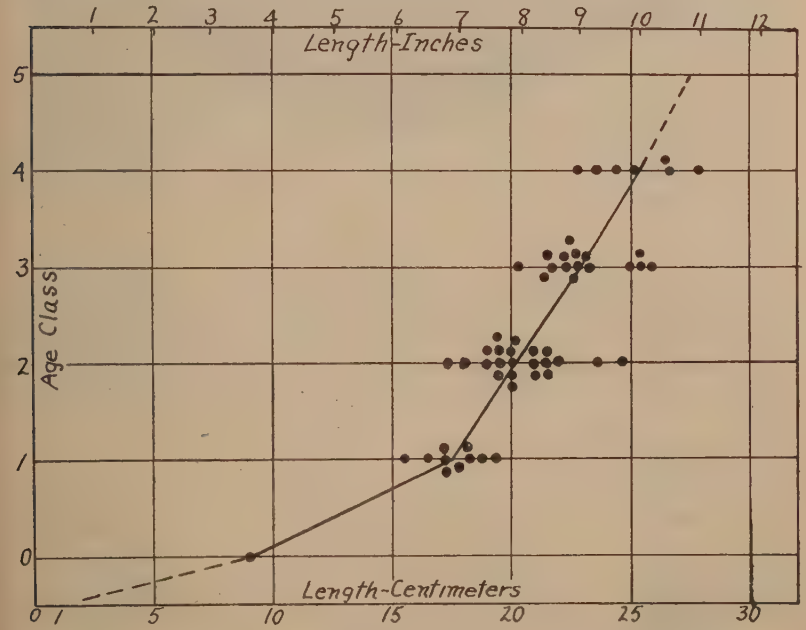

FIGURE 28. Growth rate of Sacramento Perch, Clear Lake, 1946-1947.

The graph (Fig. 28) is based on 59 scale samples taken in 1946 and 1947. Some difficulty was experienced in reading the scales, as the species apparently forms "false checks" quite readily. These checks may or may not be spawning marks. In all cases the first annulus was readily located (Fig. 29).

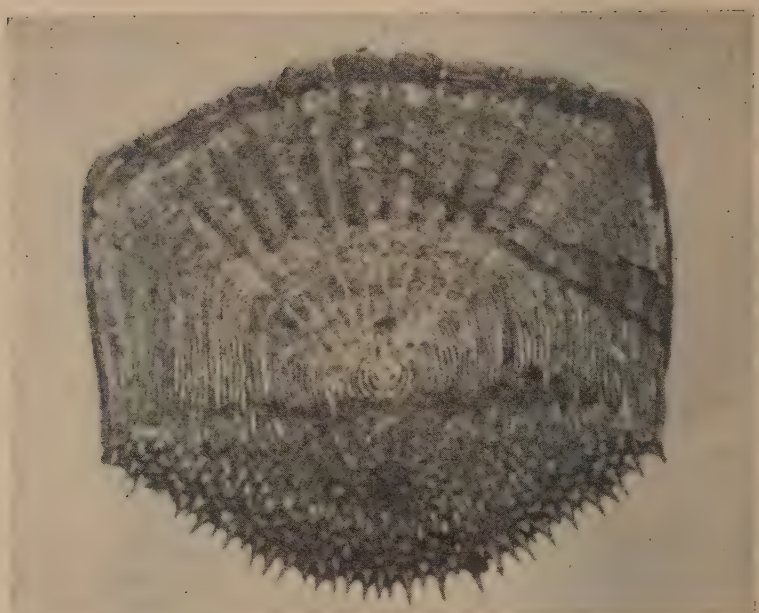

FIGURE 29. Typical scale of a female Sacramento Perch, 20.0 centimeters (8 inches) in length taken April 27, 1947. This fish is in Age Class 2.

Discussion

The spawning habits of the Sacramento Perch are unique among the family Centrarchidae. Breder (1936) gives a comprehensive review of the family's spawning habits. Of the 25 species recognized at that time, data for 20 indicated that the breeding habits of this group are remarkably uniform. The data given below are taken from page 40 of Breder's paper.

REPRODUCTIVE HABITS OF CENTRARCHIDAE

Attribute	*Manifestation*
*1. Sex recognition	Differential behavior.
*2. Spawning position	Pair headed the same way with their ventral surfaces in contact, the female reclined on one side.
3. Location of nest	In a depression in sand or gravel made by the male.
*4. Nature of eggs	Moderately adhesive, attached to gravel and each other.
5. Need for aeration	Not essential for respiration of the eggs. A protection from silting and enemies only.
6. Roles of parents	Male alone incubates and guards. Female normally leaves when eggs are laid.
7. Incubating method	Chiefly the pectoral fins aided by the anal, or swimming motions of the whole body.
8. Care of young	Guarded in nest by male until ready to swim or later.

Of these eight generalized attributes of the family Centrarchidae, only three (marked with an asterisk above) were observed in the Sacramento Perch. A fourth, territoriality, only implied in the above tabulation, is present during spawning only. The spawning pattern of this

species appears to be primitive. The absence of any nest building activity, despite a choice of site, and the absence or virtual absence of any sort of parental care [1] form a basic pattern on which the more specialized breeding behaviors of other centrarchids could be developed.

The schooling behavior of Sacramento Perch at spawning time is unique. Breder (1936) describes the tendency of many sunfishes to school prior to spawning. On moving into shallow water, these schools break up, and any aggregation into colonies Breder ascribes to limitation of suitable spawning sites. Sacramento Perch also school in the pre-spawning period, as evidenced by the fact that an angler on capturing one perch can generally take large numbers in the same locality. Unlike other centrarchids, they retain the schooling habit during the actual spawning. In addition to the school observed by the writer, various lay observers have reported large aggregations of spawning perch. After spawning the schools break up and the fish depart singly. This failure of the schools to break up until after spawning is probably a primitive characteristic and may be associated with weak sex recognition characters and behavior. It is, of course, possible to interpret the spawning pattern as degenerate. *Archoplites* is a survivor of an ancient fauna which probably antedated the barrier of the Rocky Mountains (Miller 1946). Thus, it is not surprising that its reproductive habits are generalized.

It is quite probable that the scarcity of Sacramento Perch is due to its failure to guard its eggs. In aboriginal times there were comparatively few species in the Sacramento-San Joaquin system which were likely to eat unprotected, exposed, fish eggs. Since that time black bass, crappie, bluegill, carp, and catfish have been introduced into California. Neale (1931) demonstrated to his satisfaction that of these the bluegill, carp, and catfish (*Ameiurus nebulosus* or *Ictalurus catus*) would eat eggs of spawning fish. According to his observations, the Sacramento Perch "spawns among aquatic growth," and does not build nests as do other centrachids. This is in general agreement with the data presented above. With the introduction of the species listed above, the Sacramento Perch was no longer living in the isolation which it had enjoyed since the Pliocene period. It became subjected to attack at its weakest point, its unguarded eggs, until today it is only occasionally taken by the angler. Of the myriads of eggs which were deposited on June 15th, only a few could be found on June 16th, and none on subsequent days. The locality in which they were spawned was swarming with Bluegill one to two inches long, which probably consumed the eggs.

An interesting case is that of Thurston Lake, located near Clear Lake. In this lake Sacramento Perch coexisted successfully with the Brown Bullhead (*Ameiurus nebulosus*) and the Largemouth Black Bass (*Micropterus salmoides*). In 1933 White Catfish (*Ictalurus catus*) were introduced, and shortly afterwards the Sacramento Perch disappeared completely.

Curtis (1946) experimented with 16 adult Sacramento Perch and 30 adult Green Sunfish (*Lepomis cyanellus*) which were placed in a one-third acre pond at Elk Grove, California, on March 19, 1946. When the pond was drained on August 9, 23,000 young Sacramento Perch and 1,500 young Green Sunfish were recovered. The success of the Sacra-

[1] Some tendency to stay near the incubating eggs has been reported for Sacramento Perch in very small waters (artificial ponds, etc.). No such tendency was seen here.

mento Perch was probably due to their greater fecundity and to the probability that they completed spawning before the Green Sunfish of the year were large enough to consume eggs, if they attack eggs at all. The 30 adult sunfish (average weight 7.5 ounces) would be unlikely to make serious inroads into the perch eggs, partly because of the small number in a one-third acre pond, partly because they may have been involved in spawning of their own, and possibly because adult Green Sunfish may not disturb eggs, particularly if other food is abundant. Similar experiments using Largemouth Black Bass, Bluegill, and Brown Bullhead resulted in a predominance of Sacramento Perch.

Summary

The Sacramento Perch, a holdover from an ancient fauna, is restricted to the Sacramento-San Joaquin and allied drainages. At the present time its numbers are greatly reduced. Its feeding habits are insectivorous and piscivorous.

Spawning habits are probably primitive. The schooling tendency is retained; nest building absent; and guarding manifested only by territoriality during spawning. The reduction of the Sacramento Perch population probably resulted from the introduction of species which prey on its unguarded eggs.

Recommendations

The Sacramento Perch is gravely threatened by man's introduction of alien species into is habitat. It is not only a zoological rarity, but also a worthwhile game fish. It is desirable that further studies be made to explain more clearly its decline, and that steps be taken to preserve the species in limited areas. Experiments to determine its value in pond fish culture have been initiated by the California Division of Fish and Game, and should be continued.

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NOTES ON THE BIOLOGY OF THE SACRAMENTO HITCH *(LAVINIA E. EXILICAUDA)* OF CLEAR LAKE, LAKE COUNTY, CALIFORNIA[1]

By Garth I. Murphy
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California Division of Fish and Game

Introduction

The hitch (Figure 30) is a member of the carp family (Cyprinidae). The vernacular name "hitch" is of Indian origin. The Pomo tribes living on the north and west sides of Clear Lake apply this name to it, but those living on the east and south shores call it "Chi." The genus *Lavinia* is represented by a single species, indigenous to the Sacramento-San Joaquin drainage basin and several minor but related drainages. Considerable material on its distribution and systematics is to be found in Rutter (1903), Snyder (1913), and Miller (1945).

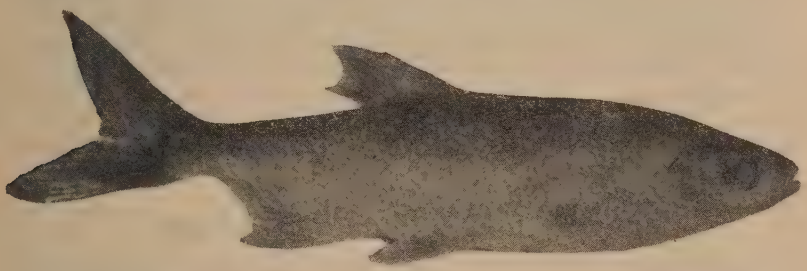

Figure 30. Male hitch, 6.7 inches long, captured at Scotts Creek, April 18, 1947

The data presented in this paper were derived from collections and observations made at Clear Lake and its tributary streams during 1946 and 1947 and from observations made by Shapovalov in 1940. Clear Lake is a large, lowland lake in central California containing a typical California warm-water assemblage of fishes. Its surface area is approximately 40,000 acres.

All measurements of fish were made to the nearest millimeter, using "fork length." Weights were taken with a spring balance reading to the nearest 25 grams. Scale samples were taken from the side of the fish, above the lateral line and below the dorsal fin.

General Ecology of the Hitch

Through its range as a whole the hitch inhabits lowland areas typified by sluggish streams and sloughs. Although frequently it lives in lakes and ponds, it apparently requires gravel-bottomed streams for successful

[1] Submitted for publication March, 1948. All photographs, except Fig. 32, by the author.

spawning. In this respect its life cycle is comparable to that of the rainbow trout.

The importance of the hitch to the sport fishery is its value as forage for the spiny-rayed game fishes. A forage fish for these species should have certain characteristics. It should be prolific. It should be innocuous in its feeding habits. It should be available. And its size should be such that it remains in the forage fish classification for at least one year. In general, the hitch fits these specifications, but the need for adequate spawning streams limits its use. On the other hand, its mandatory stream spawning and weak swimming characteristic make it a forage fish that can be readily controlled when the need arises.

Feeding Habits

No extensive study of the feeding habits of the hitch was made by the writer. Lindquist, Deonier, and Hancey (1943), found young hitch up to two or three inches long in the lake to be feeding on the eggs, larvae, and adults of the phantom midge (*Chaoborus astictopus*), commonly known as the Clear Lake gnat; and the adult hitch feeding on plankton exclusively. The stomachs of several small hitch examined by the writer contained larger plankton crustacea exclusively. Five stomachs from adult hitch captured by gill net in Clear Lake during 1946 contained only plankton, but during the early spring an adult hitch is occasionally taken by an angler using flies or worms on a small hook, which indicates the insectivorous habit is not completely abandoned in the adult. These scattered data indicate that the hitch while young (two or three inches) feeds on smaller insects and plankton, and during its adult life feeds very largely on plankton.

Spawning Habits and Larval Development

The hitch is very prolific; a 10-inch female taken in March, 1947, contained an estimated 112,000 maturing eggs. This great fecundity is probably an adaptation to offset reproductive hazards, which are numerous.

During late March and early April, after freshets caused by late spring rains, the hitch move out of Clear Lake into the tributary streams to spawn, running a few miles upstream, but not penetrating the more precipitous reaches of the streams. Figure 31 illustrates a typical reach of hitch spawning water. The gradient is slight. Most of the streams tributary to Clear Lake are of slight gradient in the lower few miles and are covered with gravel and rubble up to five inches in diameter. In the past, enormous numbers of hitch moved into the streams after the late rains. In fact, the last sizeable rain of the season is called the "hitch rain" by many local residents. Of recent years the runs have been small or nonexistent.

Shapovalov (1940) observed spawning hitch in Middle and Clover Creeks, both tributary to Clear Lake via Scotts Creek, on April 13, 1940. The following account of spawning activity is taken directly from his notes.

"Spawning was taking place in shallow areas, where the water was three to five inches deep, in moderately swift water. It was taking place mostly over fine to medium gravel, on even riffles. At this point the stream

is willow-lined. Spawning was in progress at this location at 10 a.m., when observations were first made.

FIGURE 31. Hitch spawning in Middle Creek at bridge on Lakeport-Upper Lake Road, Lake County, April 13, 1940. Photograph by Leo Shapovalov

"Spawning was also going on at the same time in Middle Creek at the State Highway 29 crossing (on the Upper Lake-Lakeport Highway). At 10.30 a.m. the temperatures in degrees Fahrenheit in Middle Creek at the above bridge were air 67.5 degrees, water 58.5 degrees. The weather was clear. The water was slightly murky. The flow of the stream was estimated to be 75 second-feet or more. The average width was about 35 feet and the average depth about 10 inches.

"Observations were continued only until 11.30 a.m., at which time spawning was still going on at the above bridge over Middle Creek. Temperatures had then risen to air 73 degrees, water 61.5 degrees.

"In spawning, the males kept close to and slightly behind the females, with their snouts near the vents of the females. Often four and five or more males attended one female, crowding over and next to one another. However, they were not observed fighting.

"The deposited eggs were not covered by the fish. On the day of observation the stream flow was receding, and as a result many thousands of eggs were exposed on gravel bars. Under such conditions, mortality among newly laid eggs must be tremendous."

The run of fish studied by the writer entered Scotts Creek on April 17, 1947, and remained in the stream until April 26th. Roily waters at the time of the run prevented direct observation of the spawning fish. Most of the observations were made at a riffle just below the mouth of Middle Creek.

Figure 32 illustrates the composition of the spawning run observed in Scotts Creek. It shows that while the males become mature at the end

of their first year, females usually do not mature until the end of their third year of life, although a spawning female of age class 1 was collected by Shapovalov in March of 1940.

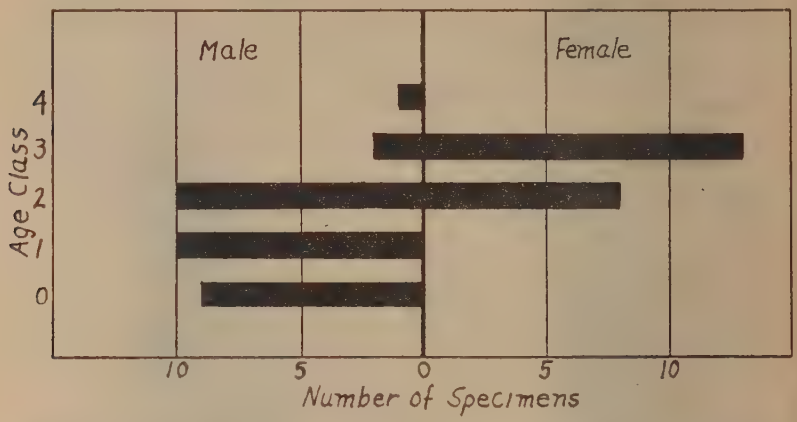

FIGURE 32. Age Composition of Spawning Hitch, Scotts Creek, Lake County, April, 1947. (Age Class 0 includes all fish that have not completed their first year of life, etc.)

In Scotts Creek eggs could not be recovered from the pools above and below the riffle but could be recovered from the riffle by a technique similar to stream bottom sampling, so it is assumed that deposition took place only in riffle areas. Since the eggs are nonadhesive and sink rapidly, they lodge in spaces in the gravel, which offer some protection during development. At the time the spawning was observed the flow over the riffle studied was 80.2 second-feet. The current speed over the riffle varied from one-quarter foot per second to $4\frac{3}{4}$ feet per second as measured by a current meter.

FIGURE 33. Hitch Eggs. The small egg was preserved immediately after extrusion, and the larger eggs 30 minutes after extrusion.

Eggs were recovered from and spawning hitch captured on the sections of the riffle having a speed of seven-eighths foot per second to 2½ feet per second, indicating that the spawning fish have definite current preferences. The eggs were very abundant in the gravel, their numbers ranging from 110 to 561 per square foot on May 8, 1947.

Shortly after extrusion the egg absorbs water and a liquid cushion is formed between the membrane and the yolk. The entire process takes about 30 minutes, but starts almost immediately. This necessitates rapid fertilization. Figure 33 shows the hitch egg before and after this process. The smaller egg was preserved immediately after extrusion and the larger eggs 30 minutes after extrusion.

An attempt was made to rear a batch of eggs. They were artificially spawned and fertilized and placed in a tray through which tap water at 62 degrees F. was run. The longest period of time the eggs survived was five days. In three days the surviving embryos were moving vigorously. On the fifth day the hearts were beating. On the basis of available evidence, it can be postulated that embryonic development takes about ten days at 62 degrees F. and that the larvae become free-swimming in approximately twenty days.

Failure of hitch spawning is readily possible. Apparently a heavy rain during late March or April is needed to bring the adults into the streams. During 1946 virtually no hitch from Clear Lake spawned. Streamside residents report that no fish ran. Hitch of the year were quite scarce and adult hitch captured during the summer were eggbound. This is thought to be due to a lack of suitable freshets in the streams. During 1947 virtually the same situation existed. A few hitch ran during the middle of March after a light rain. That only a small segment of the population spawned during this run is indicated by the "ripeness" of 19 adult females captured in Clear Lake on March 19th and 20th. On April 17th pumping operations were initiated on Tule Lake, a reclamation on Scotts Creek about three miles above the point at which the observations were made. As a result, 30,000 gallons per minute were discharged into a stream previously flowing about 5,000 gallons per minute. This created an artificial freshet. Pumping operations started at noon and by 4 p.m. spawning fish were present on the riffle under study, whereas none had been there during the morning. Examination of several other tributaries of Clear Lake the next day revealed no hitch. It is believed that a rain sufficient to freshet the streams at this time would have caused a general hitch run in all streams. Further indication that all hitch did not spawn in 1947 is given by the gill net capture on June 24, 1947, of two female hitch with freely running eggs.

Vagaries in spring rains are the greatest single hazard to successful hitch spawning. If the rains are sufficient to cause the fish to spawn, the majority of the eggs may perish before hatching through a sudden drop in the flow, exposing the gravels before the fry become free-swimming. This danger is accentuated by the comparatively long development period and by the fact that spawning coincides with the end of the rainy season. In past years there have been times when the streams have dropped so rapidly that the spawning fish were stranded. Kelsey Creek, tributary to Clear Lake, has been so choked with stranded fish that one could literally walk across the stream on the backs of fish.

A more subtle factor in the decline of the hitch is the erosion which the drainage has suffered at the hand of man. As it affects the hitch, this abuse is focused on the graveling-in of stream channels, causing surface flows to disappear prematurely, and the destruction of protective cover by overgrazing and fires causing the rainfall to runoff more rapidly. These two factors are interdependent.

It is apparent that a series of years in which weather conditions are unfavorable can cause a marked reduction in the hitch population and equally apparent that a series of good years can build up the population enormously, in view of the large number of eggs produced by the individual female.

Post Larval Life

On May 16, 1947, the average size of the hitch fry in Scotts Creek was 2.2 centimeters. On May 28th it was 2.5 centimeters (one inch). By the end of the first week in June young hitch were virtually gone from Scotts Creek and coincident with this they appeared in the upper end of Clear Lake in fairly large numbers, so it can be inferred that they migrate downstream shortly after reaching a length of 2.5 centimeters or at an age of about one month. A sample seined in Clear Lake on June 9th consisted of fish 3.3 centimeters in average length. By June 17th they had grown to 4.1 centimeters in length. By July 10th, the average size was 4.4 centimeters.

By August 1st none were taken in a series of 20 seine hauls. The best explanation is that the young hitch when they first enter the lake live in the littoral zone associated with young bluegill sunfish (*Lepomis macrochirus*), feeding on small insects and plankton. After reaching a size of approximately 5 centimeters (2 inches) they range the entire lake, feeding on plankton. An alternate explanation is that the numbers of young fish were so reduced by predation that they were present during August in too small numbers to be detected. This does not seem probable to the writer, in view of the comparative ease with which they were seined during June and July. Very probably the individual fish as they reach a certain size become open-water inhabitants, gradually reducing the density of the littoral population.

The open-water habits of the hitch make it an ideal forage fish for a large lake since in ranging the lake they provide forage in the open waters, in contrast with bluegills, which afford forage in the littoral zone only.

Growth Rate

Figure 34 illustrates the growth rate of the hitch as calculated from scales, a typical example of which is illustrated by Figure 35. It can be seen that males of comparable age are smaller than females and that they remain in the forage fish class into their second year. Most of the fish on which Figure 34 is based were taken from the spawning run; so the individuals are at the end of the year of life indicated since the annulus can be expected to form in the immediate post-spawning period. The length-weight relationship is illustrated by Figure 36.

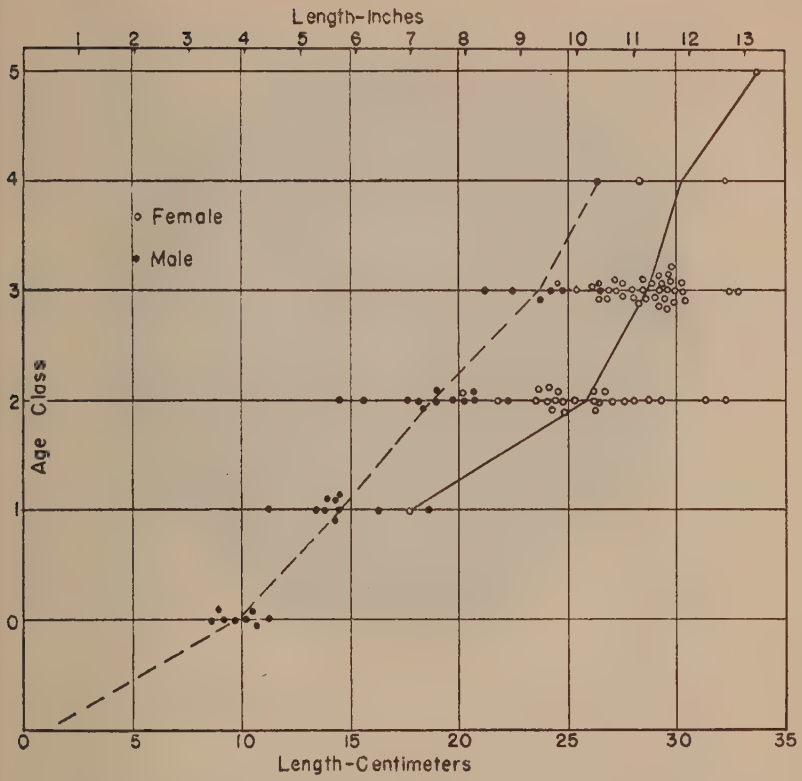

FIGURE 34. The Growth Rate of Hitch in Clear Lake, 1946-1947

FIGURE 35. Scale from a Female Hitch 24.2 Centimeters in Length Taken April 19, 1947, in Scotts Creek. The fish is in Age Class 2.

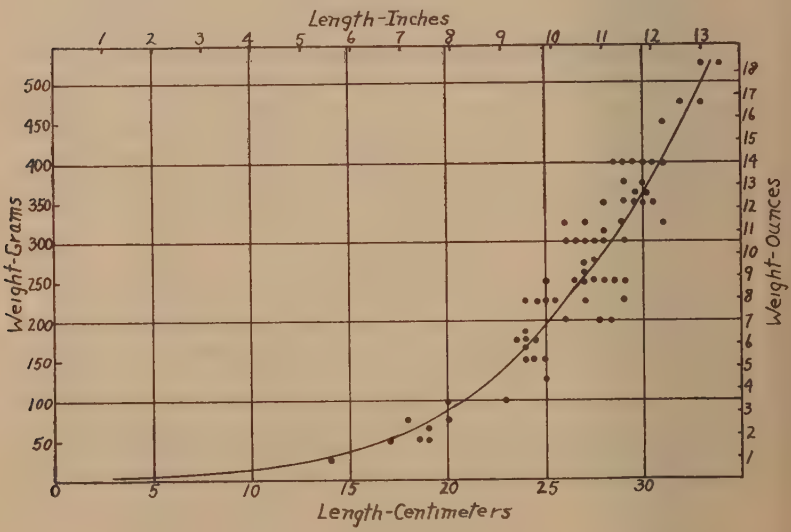

FIGURE 36. The Length-weight Relation of Hitch, Clear Lake, 1946-1947. Curve fitted by eye

Discussion

The nonadhesive eggs of the hitch with their protective cushion are unusual in cyprinid fishes. They generally have adhesive eggs and no noticeable cushion. In an adhesive egg a cushion is unnecessary since the eggs are securely fastened in a safe place. The hitch eggs are adapted to their haphazard deposition in gravels which are subject to considerable shifting. It is hard to imagine a high survival of these eggs without this cushion.

Miller (1945) reported numerous hybrids (*Lavinia exilicauda harengus* x *Hesperoleucus symmetricus subditus*) in the Pajaro River system. Normally *Hesperoleucus,* a much smaller cyprinid inhabiting streams only, spawns in shallow water with very slight current. Its eggs are adhesive and are deposited under rocks. In addition, spawning takes place when the streams are clear and have subsided from the spring freshets. However, if the stream flow regime was such that adult hitch were trapped in pools inhabited by *Hesperoleucus* they might extrude eggs and sperm in areas in which *Hesperoleucus* were spawning.

In Clear Lake hitch apparently have been unable to spawn successfully since 1943 or 1944. This means that the supply of forage fish has been considerably lowered and it is believed that this is one of the chief factors causing a decline in the Clear Lake sport fishery. There are in addition other forage fishes which have been greatly reduced in Clear Lake in recent years.

Summary

The hitch, *Lavinia exilicauda* (family Cyprinidae), is a valuable forage fish. Juveniles feed on plankton and small insects, and adults almost exclusively on plankton.

The hitch is a stream spawner, running into the streams in late spring. The females first spawn at the end of their first year; and females at the end of their third year (age class 2). Spawning takes place in riffle areas. The eggs sink and lodge in crevices in the gravel, but are nonadhesive. Shortly after deposition the egg absorbs water, and the space between the membrane and the yolk fills with liquid, protecting the developing embryo. Development up to the free-swimming stage probably takes about 20 days at 62 degrees F. Success of reproduction is completely dependent on run-off. This fact, coupled with the fecundity of the hitch, results in marked fluctuations in the population.

The young migrate to the lake shortly after reaching a length of 2.5 centimeters (1 inch). The juveniles occupy the littoral zone of the lake until they are approximately five centimeters (2 inches) in length, after which it is believed that they become open-water inhabitants. As an open-water forage fish they fill a need in a large lake, whose productivity, if dependent on bluegill, sunfish, would be limited to the littoral zone. Males of comparable age are smaller than females.

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KOKANEE IN CALIFORNIA

By Brian Curtis and J. C. Fraser[1]
Bureau of Fish Conservation
California Division of Fish and Game

The "kokanee" (*Oncorhynchus nerka kennerlyi*) was first planted in California waters in 1941. This is a landlocked form of the Pacific sockeye or red salmon. It is native to the Pacific Northwest, where it is also called "little redfish" and "silver trout." Under highly favorable conditions it may reach a size of five pounds. Twelve to fourteen inches is average, and under poor conditions it never exceeds eight inches.

It is preeminently a lake resident, and may spawn on gravelly lake shores as well as in streams connecting with lakes. It matures and spawns at the end of its third or its fourth year, and like all Pacific salmons dies after spawning. It prefers cool waters, and therefore goes deeper as temperatures rise in summer. Although its food is made up largely of plankton, the minute animals which drift in the water, it can be easily taken in some lakes on hook and line in spring and autumn. In summer it is harder to catch. Trolling with flashers and baited hook, and still-fishing a few feet off bottom, are favored methods; fly-fishing can be successful in the late afternoon in spring or fall when the fish are near the surface. The kokanee puts up a good fight, but has a tender mouth and is hard to land. It is excellent eating. In its native regions it has furnished abundant fishing and is looked upon as a valuable element in the angling resources.

The decision to introduce it to California was based in part on its popularity in certain sections of the northwest, and in part on its plankton feeding habits, which suggested that it might do well in reservoirs where fluctuations made for poor production of bottom food. Salt Springs Reservoir on the North Fork of the Mokelumne River off the Carson Pass Road was selected for the initial test; its level fluctuates extensively, and it is so located that little harm could be done if the kokanee turned out to be an undesirable citizen. One hundred thousand eggs obtained in late 1940 from Idaho through the U. S. Fish and Wildlife Service were hatched at the Basin Creek State Fish Hatchery near Sonora, and 67,000 fingerlings were planted in July of 1941 at a length of a little under two inches. (In the State of Washington, incidentally, where great numbers of this species are produced, planting at a very small size is favored.) The Salt Springs area was closed shortly thereafter as a war measure, but tests in the spring of 1943 showed the kokanee to be abundant and easily caught, at a size of about 10 inches. In November of 1943, at the end of their third year, and at a length of 11 to 12 inches, they were ready to spawn, and some 300,000 eggs were taken from 626 females. A total of over 3,000 fish were caught in seines at this time, 4½ percent of the number planted, and since many more were present than were netted, a good survival was indicated.

[1] Submitted for publication March, 1948.

FIGURE 37. Kokanee from Salt Springs Reservoir, November, 1943. Female in center, male below and above. Photograph by Malcolm Wilson

These results were sufficiently encouraging to warrant further stocking, which has been carried out as shown in the following table:

STOCKING OF KOKANEE IN CALIFORNIA

Name of water	*Date of planting*	*Source of eggs*	*Number planted*	*Size in numbers per oz.*
Salt Springs Reservoir, Amador County	1941—7/12–16	Idaho	67,000	27
Strawberry Lake (also called Pinecrest), Tuolumne County	1944—8/12–19	Salt Springs	106,000	22–32
	1945—7/28	Montana	99,000	25–40
	8/6			
	1947—5/28	Washington	284,000	140–265
	6/16			
Waterhouse Lake, Tuolumne County	1944—8/3	Salt Springs	700	32
Echo Lake, El Dorado County	1944—7/5–20	Montana	69,000	51–72
	1945—8/2–7	Montana	79,000	52
Donner Lake, Nevada County	1944—6/22	Montana	83,000	270–280
	7/19			
	1945—8/3–8	Montana	74,000	52
	1947—5/28	Washington	100,000	265

NOTE:

Average lengths of fish are approximately:
1⅝ inches at 25 per ounce.
1¼ inches at 50 per ounce.
1 inch at 100 per ounce.

The results have been uneven. Echo Lake has been the most disappointing. In this high, rocky basin it has been very difficult to produce good fishing, and it was hoped that the plankton-eating kokanee would solve the problem. However, growth has been poor here, the fish not exceeding eight to nine inches at maturity, and anglers have shown little interest in them. Strawberry Lake has provided the best fishing, especially when it was drawn down in late summer of 1946; large catches were made at this time, with the kokanee reaching a size of 10 inches. Donner Lake has produced the largest fish, the spawners running from 12 to 16 inches. The kokanee aroused little angler interest here at first, but their popularity seems to be growing, and more are being caught every season.[2]

Kokanee have appeared in other waters than those in which they were planted. About 100 were found in December, 1946, spawning in the small stream formed by the water running from the Tahoe Hatchery into the lake. These had evidently escaped in 1944 from the hatchery troughs where they were reared, and were returning to the "home stream." In the Truckee River spawning kokanee appeared just below the Tahoe Dam in the winter of 1947-1948; these are presumed to have migrated out of Donner Lake. And in 1946 a number of Kokanee went out of Strawberry with the declining water and down to Lyons Reservoir. In no case has any harm come from the escape of kokanee into other waters, nor is any possibility of harm foreseen.

In California all kokanee so far observed have matured at the end of their third year. Kokanee were seen spawning by the junior author in Donner Lake in November of 1947, in water varying in depth from one-half to three feet, and from right along the shore-line to 20 feet out. Concentrations of fish were found near the mouths of the small inlet streams on the north side where the lake bottom was sandy with some pebbles and a few rocks, and many also spawned along the north shore where water trickled in from the road culverts. Water temperature was 45 degrees Fahrenheit.

The spawning pattern insofar as it could be observed resembled that described by Schultz (1937), with such differences in detail as might be attributable to stream spawning in Schultz's report as against lake spawning here. Only one female was seen in the process of building a nest, and unfortunately she was in the center of a group of fish where it was impossible to follow her actions closely, or those of any males involved. She apparently rolled over on her side and dug vigorously with the posterior part of her body for a few seconds, then circled away from the nest; occasional interruptions would be caused by a general milling around of all the fish in the vicinity. Actual pairing of fish seemed to be the rule.

Spawning activity began by male and female circling the nest, one behind the other. Eventually the female would pass over the center of the nest, and come to a stop there—sometimes on the first pass, and sometimes on the second or third. The male would then join her, and both would vibrate at which time it is presumed that the sex products were deposited. The female invariably dug into the sand near the end of the vibrations, raising a small cloud of fine particles. All of this took about

[2] Reports from Donner Lake received after this paper went to press tell of excellent fishing in May, 1948, with many limit catches of kokanee weighing about one pound each.

10 seconds, after which circling was resumed. Individual pairs were seen to repeat this process four or five times over the same nest, presumably with deposition of eggs each time. Covering of the eggs was apparently accomplished by the digging action of the female at the end of each period of vibrations, but it is possible that a further and final covering took place after the completion of egg deposition in any particular nest.

Unfortunately Donner Lake was drawn down very heavily in January and February, and all of these spawning beds were left high and dry in frozen ground.

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EXPERIMENTS ON THE MANAGEMENT OF COLORADO RIVER BEAVER[1]

By Arthur L. Hensley[2] and B. C. Fox[3]

Introduction

The Colorado River or Sonora Beaver (*Castor canadensis repentinus* Goldman) in that portion of the Colorado River constituting a common boundary between the States of California and Arizona presents a joint management problem requiring mutual understanding and uniformity in the adoption of regulations or policies by the state game departments.

The development of a beaver resource management plan is influenced by two major considerations: that which is to the best interest of this resource of the two states, and that which is most feasible from the standpoint of administration by the two game departments charged with this responsibility. Further work is in progress, and the express purpose of this paper is to record the preliminary findings of the cooperative program as undertaken by the two game departments.

The authors wish to express their sincere appreciation to those members of the California Division of Fish and Game, Arizona Game and Fish Commission, United States Fish and Wildlife Service, and others who participated in the annual surveys and other functions of the program. Thanks are also due to the trappers employed in the program for their timely suggestions and cooperation.

This program presented the two states with an opportunity to collect data relative to methods of procedure applicable to future management plans for other parts of either state. It was therefore agreed to use the Colorado River as a proving ground upon which to experiment and, if possible, demonstrate the potential value of the beaver resource under a plan of share cropping by managed trapping.

Since the regulations governing operations of the Arizona Game Department permit more freedom of operation than those of the California agency, it was agreed that Arizona would assume supervision and administration of the program on the basis of joint acceptance of recommendations resulting from cooperative surveys made by representatives of both states.

Objectives

To secure and record as much information as time permitted relative to such important points as:

1. Development of a practical technique for estimating numbers of beaver that can be safely harvested from a given area or portion of a stream on the basis of a sustained annual yield.

[1] Submitted for publication April, 1948. A portion of this study was part of Federal Aid in Wildlife Restoration Project California 5-R; a survey of the fur resources of the State of California.

[2] Bureau of Game Conservation, California Division of Fish and Game.
[3] Arizona Game and Fish Commission.

2. Determination of the most feasible and economical plan of harvesting beaver with employed trappers.
3. Types and use of equipment necessary for the successful operation of such a plan.
4. Methods of marketing to obtain the greatest monetary returns.
5. Determination of occurrence of disease in Colorado River beaver.
6. Collection of weights and measurements of adult beaver.

FIGURE 38. Most of the survey was performed in small boats powered by outboard motors

Methods

The first joint survey of the Colorado River beaver was undertaken in September of 1943 and thereafter in October for the four subsequent years.

The initial procedure involved crisscrossing the river from bank to bank wherever the channel permitted, making counts of beaver lodges or houses, freshly used beaver slides, beaver bank burrows, beaver scent mounds, and general observations.

The recording of beaver bank burrows excavated in the stream banks was attempted during the first three surveys and thereafter discontinued. It was found that these counts could not be made with any degree of accuracy because of almost daily water level fluctuations due to controls exercised at Boulder Dam located approximately 60 miles above the upper boundary of the study. These counts, consequently, were of no value for comparative analysis in attempting to measure beaver population density in the river. Due to frequent blockage by sand bars during low water periods of the day, it was difficult to obtain counts of the beaver slides at such sites. It is estimated that Table 1 represents about 40 percent of the total number of the beaver slides and 80 percent of the beaver houses present in the river for, theoretically, only 50 percent of the beaver slides would have been observed and counted by the method used. No beaver dams were observed in the Colorado River.

FIGURE 39. Newly constructed beaver lodge on bank of Colorado River above Needles, California

FIGURE 40. A beaver lodge constructed in midstream below Blythe, California

FIGURE 41. A typical beaver slide or runway showing recent use

FIGURE 42. A beaver scent mound showing extensive use.

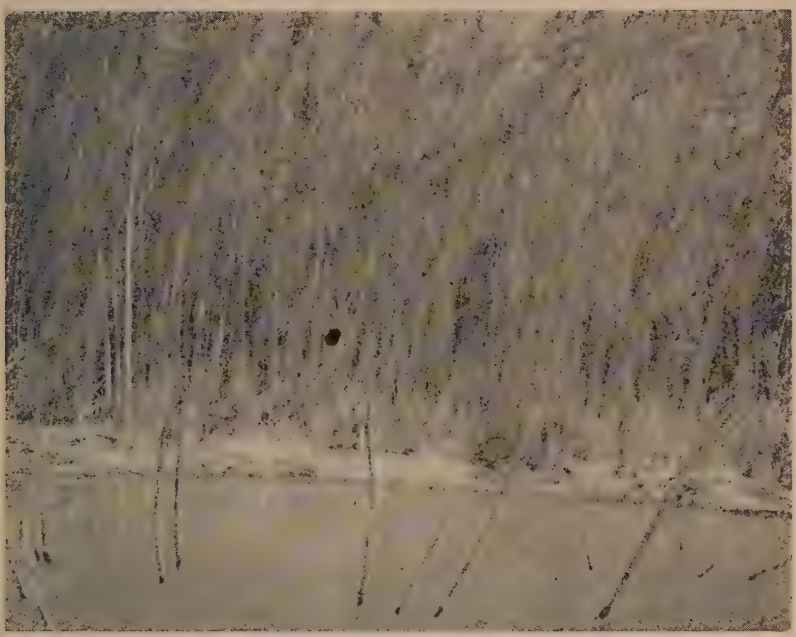

FIGURE 43. Shore cover on Colorado River between Imperial and Laguna Dams. This characteristic stand contains an abundance of willow

General observations for the most part were limited to the abundance of principal food plants and degree of utilization in reference to the potential carrying capacity in given portions of the stream. Food plants consist largely of cattail (*Typha latifolia*), tule (*Scirpus acutus*), willow (*Salix* spp.), cottonwood (*Populus fremontii*), salt sedar (*Tamarix galica*), arrowweed (*Pluchea sericea*) and water wally (*Baccharis glutinosa*). Although extensive cutting of cottonwoods and willows were observed in several locations, there were only a few spots where overutilization of food plants had become critical.

A number of residents living adjacent to the river were interviewed to obtain information relative to poaching and display of interest in the attempted management of this resource by the states.

No effort was made to ascertain actual numbers of beaver present in the river as this would have required more time than was available. Rather emphasis was placed on two major objectives: (1) the determination of the comparative density of the population in various sections of the river and (2) the development of a yardstick to estimate, with reasonable accuracy, the number which can safely be removed without adverse influence on the distribution of the population, assuring a sufficient residue of seed stock to produce a harvestable yield year after year.

The river was arbitrarily divided into sections for the purpose of recording data to use later as a basis for future operations, numbered as follows:

1. Intersection of the California, Arizona, and Nevada boundaries to Needles, California.
2. Needles, California, to Topock, Arizona.
3. Topock, Arizona, to Parker Dam.
4. Parker Dam to Headgate or Squaw Dam.
5. Headgate or Squaw Dam to Blythe, California.
6. Blythe, California, to Imperial Dam.
7. Imperial Dam to California-Mexico boundary.

Certain of these river sections were grouped together and designated as trapping units as follows:

1. Intersection of California, Arizona, and Nevada boundary to Topock, Arizona (Comprising river sections 1 and 2).
2. Parker Dam to Blythe, California (Comprising river sections 4 and 5).
3. Blythe, California, to California-Mexico boundary (Comprising river sections 6 and 7).

FIGURE 44. Beaver cuttings between Squaw and Parker Dams demonstrating overutilization

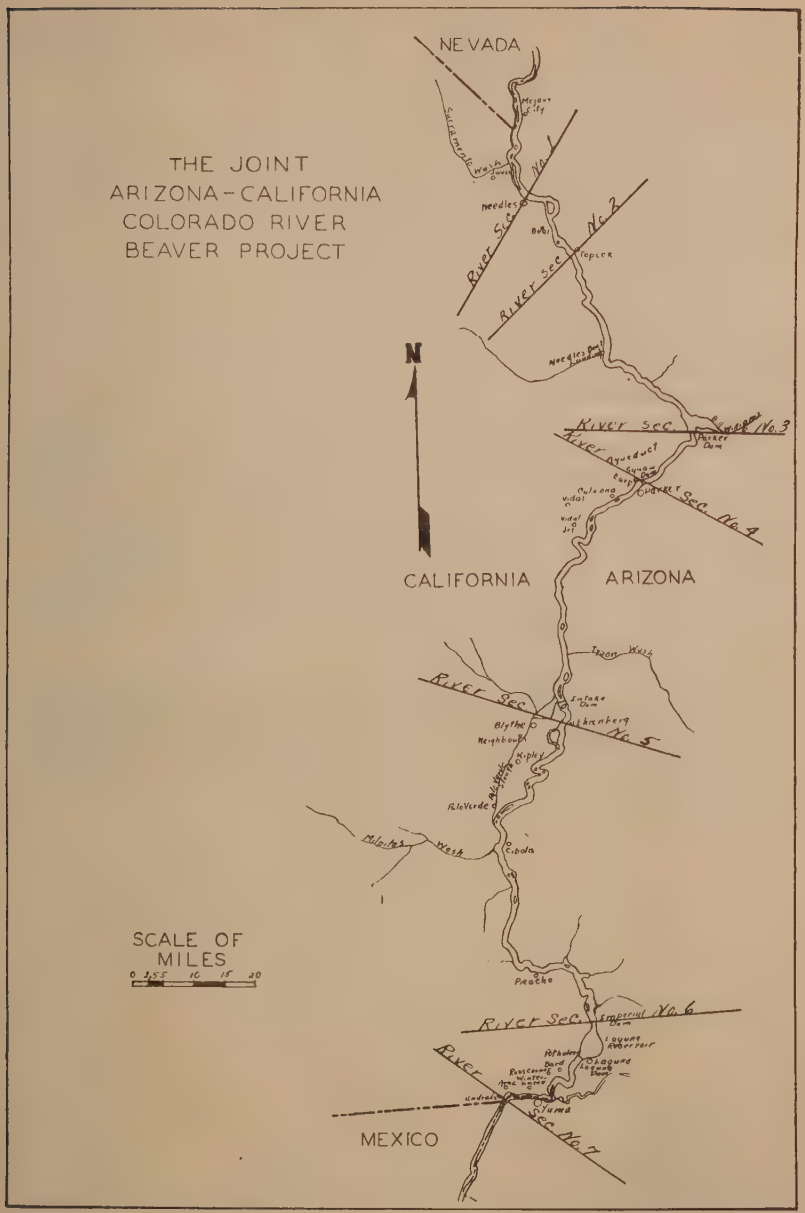

FIGURE 45. Map indicating the river sections used as subdivisions in this study

River section 3, comprising all of Lake Havasu (formed by Parker Dam), is not included as the habitat was destroyed by the creation of the lake and will require several years to redevelop sufficient food supply to support more than a limited number of beaver.

The census methods employed to obtain data were relatively the same each season except that the 1947 survey counting was done by one individual whereas in previous surveys two or more participated in making counts. The 1947 method resulted in a lesser area of each bank counted; consequently the total count in comparison to the former surveys was lowered. This does not necessarily indicate a lowering in the trend of population.

The data presented in Table 1 is only useful on a long term basis. In its present form it is indicative rather than conclusive except for the trend of density in population which has more or less remained constant in relation to the numbers of beaver removed.

Not including those beaver poached (of which some evidence was found) it was recommended that 1,150 beaver be harvested of which 1,054 were taken during the course of the four seasons included in this analysis.

Due to wartime rationing of gasoline and tires, shortages of materials and supplies, limited personnel, and inability on the part of California to lend the necessary assistance in supervising the program, the animals were not taken as recommended. The quota was determined after study of the survey data by discussion among the personnel involved based on their past experiences and what they thought to be a logical number to yield results possible of analysis and still be within the limits of surplus animals.

It is evident that the evolution of any systematic management plan from Table 1 is at present questionable since the recommendations were not followed during the 1943 and 1944 seasons. The take was either too few or too many, but it is hoped that in the future conditions will permit the carrying out of the program as planned and in accordance with annual recommendations.

TABLE 1

Survey Data

River section	App. river miles	Beaver slides					Beaver lodges					Recommended take					Number taken				
		1943	1944	1945	1946	1947	1943	1944	1945	1946	1947	1943	1944	1945	1946	1947	1943	1944	1945	1946	1947
1	10	271	993	111	63	200	5	12	7	7	8	75	65	0	0	0	25	17	0	0	0
2	11	75	------	46	95	50	------	------	4	6	8	0	0	0	0	0	0	0	0	0	0
3	32	------	------	6	25	78	4	------	4	5	2	0	10	0	0	0	0	0	0	0	0
4	11	434	461	369	218	201	16	13	16	13	6	75	75	60	0	0	0	78	60	0	0
5	55	522	1,119	645	597	730	15	28	27	23	21	100	150	0	0	0	26	240	0	0	0
6	54	952	626	706	855	556	24	20	20	30	31	150	100	50	0	0	0	297	145 [1] 279	35	0
7	20	40	481	338	183	123	------	13	8	4	2	100	100	40	0	0	17	78	342	15	0
Totals	193	2,294	2,880	2,221	2,036	1,938	64	86	86	88	78	500	500	150	0	0	68	710	226	50	0
Percentages based on total beaver slides	------	------	------	------	------	------	------	------	------	------	------	22%	17%	6.7%	------	------	2.9%	24%	8.1%	2.4%	------

[1] 45 of the 226 total from Section 5 were used for transplanting purpose by the Arizona Game and Fish Department.
[2] 31 of the 79 total were nuisance beaver from Palo Verde Valley.
[3] 3 of the 42 total were nuisance beaver from drainage canals near Laguna Dam.
[4] 1946 total of 50 were nuisance beaver from Palo Verde and North Gila irrigation canals.

Management Procedure

Methods were modified during each season's procedure in an effort to determine the plan best suited to the successful operation and management of the activities. The two procedures given trials to date were roughly as follows:

Procedure 1	Procedure 2
1. Employment of salaried trappers including a $1 bonus per pelt for well-handled pelts rather than a share basis. All equipment such as boat, motor, traps, and personal belongings furnished by the trapper; incidental supplies and repairs were furnished by the State Game departments.	1. Trappers were paid at the rate of $5 per pelt and were provided with all equipment with the exception of bedding, food, and other personal requirements. A provision was included to permit this rate to be increased to $10 if the trapper's take at $5 per pelt did not provide him with an adequate wage.
2. The number of trappers required to take the estimated quota were employed and supervised by the State of Arizona.	2. The necessary number of trappers required to take the estimated quota were employed and supervised by the State of Arizona.
3. The cost of operations, including salaries, maintenance, trapping, pelting, transporting, marketing, etc., were deducted from the total revenue from the sale of pelts and the balance was divided equally between California and Arizona.	3. The trapping program was administered by the State of Arizona and all costs of operations (including equipment costs incurred by both states) were paid from the proceeds of the sale of beaver pelts and 50 percent of the balance was remitted to the State of California.
4. All other fur bearers accidentally caught by trappers during trapping operations were to be saved, prepared for marketing, included in the sale of pelts, and proceeds were to be equally divided by the two states. Beaver were trapped from the river proper. The river proper was defined as the main channel, all true sloughs whose channels leave and rejoin the main river whether flowing through during the period or not, and all tributaries and diversion canals for a distance of one-half mile from the main channel.	4. Animals were trapped only from the river proper. The river proper was defined as the main channel, and all true sloughs whose channels leave and rejoin the main river whether flowing through during the period of trapping or not, and all tributaries and diversion canals for a distance of one-half mile from the main channel. Trappers while engaged on this project were not allowed to operate trap lines for the purpose of taking fur bearers other than beaver.
5. The State of Arizona was responsible for the sale of the beaver pelts with the proviso that the pelts be sold to the highest bidder at public auction and that the State of California be provided with copies of the bids at the time remittance was made.	5. The sale of the pelts was placed in the hands of one of the Western States Fur Auction Houses for marketing at the best discretion of the Fur Auction Exchange and payment for pelts was remitted to the Arizona Game and Fish Commission.

During the 1943 and 1944 seasons trapping activities were performed as per Procedure 1. Allegedly experienced trappers were employed from among the group of men who were known to have trapped beaver for many years along the Colorado River.

The few experienced trappers worked a very short time, apparently preferring to trap elsewhere rather than to work for a salary of $150 per month plus the one dollar bonus per beaver, with the result that it became necessary to employ inexperienced, poorly equipped trappers to continue the operations for the balance of the season. This set of circumstances

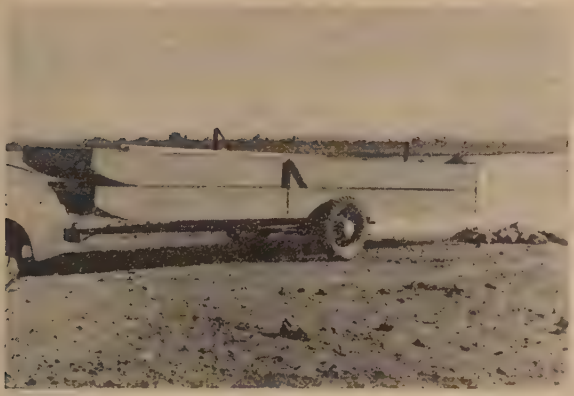

FIGURE 46. River barge set up on trailer for transportation from one trapping headquarters to another

FIGURE 47. River barge assembled for use by trapping crew. This provided living quarters as well as working space.

along with the lack of adequate equipment and knowledge was responsible for the virtual failure of the program as recommended under this procedure.

Under Procedure 2 three crews consisting of four experienced trappers and their helpers followed this procedure without difficulty; in fact, their enthusiasm was so great that 710 beaver (210 more than the number recommended for harvesting) were removed before the operation was arbitrarily halted.

Costs

The following items of equipment were purchased by the two game departments to insure the successful prosecution of Procedure 2:

Number	*Items*	*Cost*
5	Outboard motors, 1 22-h.p. 4 10-h.p.	$1,184 00
1	Portable store room, 20′ x 24′	378 84
3	Trapping work boats, 12′ x 4′	303 64
3	River scow boats, 8′ x 20′, split sections, 4′ x 20′	595 55
4	Tents, 8′ x 12′, for living quarters on scow boats	202 68
4	Canfield camp stoves with ovens	26 00
100	Traps, size 14, and 6 setting clamps	270 85
100	Drying frames, ⅜″ bolt stock in 9′ lengths	32 98
100	#12 gauge smooth wire	5 45
	Hand tools and miscellaneous supplies	363 52

In addition there were other incidental items of equipment and supplies, such as gasoline containers, gasoline, oil, etc., purchased during the course of the project.

The following is a recapitulation table of costs incurred for operations for each of the four seasons during which the program has been in effect:

Season	*Trapping contracts*	*Equipment purchases*	*Supplies*	*Repairs*	*Miscellaneous*	*Totals*
1943-44	$844 00		$88 68	$30 00		$962 68
1944-45	3,657 00	$2,999 53	131 29	232 23	$1,606 83	8,790 50
1945-46	1,100 00	328 51	152 54		289 06	1,870 36
1946-47	350 00		16 25		61 10	437 35
	$5,951 00	$3,328 04	$398 76	$262 23	$1,956 99	$12,060 89

FIGURE 48. Portable storehouse located above Fort Mohave, Arizona, used for storage of equipment when not in operation.

Equipment, when not in use between seasons, was stored in a portable storehouse (Figure 48) located about 10 miles above Fort Mohave on property owned by the Arizona Game Department.

Marketing

The marketing of pelts for the two seasons of 1943-44 and 1944-45 was handled as agreed under Procedure 1 by inviting resident and non-resident raw fur buyers to submit competitive sealed bids on the different lots of pelts and castors.

This plan worked well the first season, 1943, when the market was on the uptrend and there was no price ceiling established for this kind of beaver skin by the Office of Price Administration. Seven buyers of raw furs submitted competitive bids and from the sales receipts the O. P. A. established a maximum ceiling price of $38.50 per skin for beaver taken between Boulder Dam and Mexico.

FIGURE 49. Method of drying beaver pelts on adjustable circular hoops used for the purpose of keeping skins uniform in shape.

At the 1944 sale there were nine buyers bidding. Indications were that the entire group had mutually agreed not to bid over a certain amount and later to portion the lots accordingly, resulting in an offer of only $17.09 per pelt. This offer was rejected by the game departments and after much discussion, the offer was increased to $23.01 per skin. This later offer was accepted even though not favorable in view of the ceiling price established the previous season.

During the seasons of 1945-46 and 1946-47 the marketing was handled under Procedure 2 by shipping the pelts direct to one of the

larger fur auction houses to be sold at their discretion. By this time there was a decided slump in the fur market, yet an increase of $8.23 per pelt was realized above the previous season's average ($23.01) at the peak of the fur market.

The usual method of grading beaver pelts is based on several factors: care in preparation of the pelt; damage to pelt prior to preparation; quality of fur as to texture, color, density, and size, according to the accompanying scale:

Classification	*Size*	*Condition*
Blankets	65" or more	#1—Excellent
Extra large	60"-64"	#2—Good
Large	55"-59"	#3—Fair
Medium	50"-54"	#4—Poor
Small	45"-49"	
Kits	44" or smaller	

Table 2 presents a recapitulation of the sales of pelts, castors, and disbursements of the sales receipts of the four seasons. Table 3 illustrates a sample of the variations in grades and average prices as received for the 1945-46 season. The importance of handling and preparing pelts for

TABLE 2

Average Sales Receipts

Season	Number of pelts	Sale receipts of pelts	Average price per pelt	Sale receipts of castors	Total receipts
1943-44	68	$2,082 16	$30 62	$47 60	$2,129 60
1944-45	710	16,337 92	23 01	370 47	16,708 39
1945-46	181	5,655 50	31 24	81 45	5,736 95
1946-47	50	602 25	12 04	15 66	617 91
Totals	1,009	$24,677 83	$24 22	$515 18	$25,192 85

Total gross receipts	$25,192 85
Total cost of operations	12,060 89
Net profits	13,131 96
50 Percent net receipts, California	6,565 98
50 Percent net receipts, Arizona	6,565 98

TABLE 3

Grade Analysis

Number of pelts	Grade number	Grade	Average prices received	Total receipts
32	1	Blankets	$47 00	$1,504 00
68	1	Extra large	39 00	2,652 00
19	1	Large	31 00	589 00
10	1	Large medium	23 00	230 00
8	1	Medium	19 00	152 00
10	2	Small	11 00	110 00
5	3	Blankets	16 75	83 75
5	4	Blankets	13 75	68 75
9	3	Extra large	14 75	132 75
5	4	Extra large	9 75	48 75
3	3	Large	12 75	38 25
2	4	Large	8 75	17 50
5	3 and 4	Medium and small	5 75	28 75
181		Average	31 24	$5,655 50
		Castors, 4 cents per pound		81 45
				$5,736 95

market was given considerable attention which is evident from the figures presented in Table 3 (see grade numbers) but lost in the average prices as presented in Table 2.

Disease Study

During the month of January, 1945, a total of 35 beaver, 17 female and 18 male, of all ages were examined for disease by Dr. Carlton M. Herman, Parasitologist, of the California Division of Fish and Game Disease Laboratory.

The examinations showed that 27 of the 35 animals examined, or 77 percent, were parasitized internally by paramphistome flukes *(Stichorchis subtriquetus)* in the cecum. This is probably the most common parasite of beaver and is found throughout the beaver range. Many were infested with parasitic beetles *(Platypsylla castoris)* which are found on the skin and in the fur. No gross evidence of tularemia was found. None of the animals examined showed any evidence of being in poor or unhealthy condition. Most of those found infected with paramphistome flukes had less than 10 worms; one had 394. No evidence of embryos was found in any of the females examined.

Table 4 shows the incidence of cecal flukes *(Stichorchis subtriquetus)* by age class of the 35 animals examined.

TABLE 4

Incidence of Cecal Flukes by Age Classes

Estimated age	Sex	Numbers examined	Positive	Percent	Negative
1 year	Females	4	2	50	2
1 year	Males	5	4	80	1
Total 1 year	Both	9	6	66.6	3
2 years	Female	1	0	0	1
2 years	Male	1	0	0	1
Total 2 years	Both	2	0	0	2
Adult	Females	12	11	91.6	1
Adult	Males	12	10	83.3	2
Total Adults	Both	24	21	87.5	3
Totals		35	27	77.1	8

Weights and Measurements

During the 1946 season's trapping activities 10 fully adult beaver, consisting of five males and five females, were selected as a representative sample from 40 trapped specimens and the skulls presented to the University of California Museum of Vertebrate Zoology at Berkeley, California. Before submission to the museum, records were taken of the weights and measurements. These are summarized in Table 5.

Summary and Conclusion

This study, a cooperative beaver management experiment by the States of California and Arizona for that portion of the Colorado River

constituting a common boundary between the states, was made to secure as much information as possible on methods for the development of management plans which might be applicable here or in other parts of either state. Surveys were made each year to determine the density of the population and to evaluate the effects of cropping. Harvesting beaver on a per pelt basis proved more satisfactory than on a basis of salaried trappers. Equipment purchased by the states made it possible to maintain a higher efficiency in the trapping activity by reducing the loss in trapped animals and damage to pelts. Systematic trapping requires close supervision or the animals will not be cropped to the best advantage or in the predetermined numbers.

This program was carried on during the period 1943-1947 inclusive. Total costs of operation (except administrative costs) for the four seasons was $12,060.89. Total gross receipts for the four seasons' sale of 1,009 beaver pelts was $25,192.85 of which $13,131.96 was net profit divided

TABLE 5

Beaver Weights and Measurements[1]

Sex	Weight in pounds	Total length in inches	Tail length in inches	Hind foot length in inches	Ear notch length in inches
Male	56	45	10⅝	6¾	1⅞
Male	56	48⅜	12½	7½	1½
Male	*53	45½	11⅞	7	1½
Male	41	44	10½	6¾	1½
Male	36	43⅝	12	7	1⅜
Totals	242	226½	57½	35	7⅝
Average	48.40	45.30	11.50	7	1.46
Female	59	49	13	7	1½
Female	59	47¾	12¾	7	1½
Female	48	42¾	11⅞	7	1⅜
Female	†46	41¼	11¾	6¾	1½
Female	43	43½	11¾	6⅞	1½
Totals	255	224¼	61⅛	34⅝	7⅞
Average	51	44.85	12.23	6.93	1.49
Total all	497	450¾	118⅝	69⅛	14¾
Average all	49.6	45.09	11.86	6.94	1.48

[1] Beaver taken on the Colorado River between Milpitas Wash (Arroyo Seco) and the head of the Imperial National Wildlife Refuge on February 1 and 2, 1946.
* 4 pounds deducted (damp).
† 2 pounds deducted (damp).

equally between the two states. Some evidence of beaver poaching was found, but the degree of frequency and extent was not determined.

The marketing of pelts through the fur auction exchange system was found more profitable economically and more convenient than the method of requesting resident raw fur buyers to submit competitive sealed bids. Because of their lower quality in color and fur density there is less demand by the fur industry for pelts from this area than for those from other parts of either state.

At no time during the study were any beaver dams found in the river proper. The beaver in those portions of the river near Blythe, California, and near Imperial and Laguna Dams above Yuma, Arizona, are for the most part considered nuisance beaver because of agricultural activities

requiring diversion of water for irrigation through diversion ditches, which the animals frequently block.

In general the animals were found to be in good condition with no evidence of disease.

This paper presents preliminary data obtained thus far in this study. No attempt has been made to draw conclusions or predict results from the data obtained to date. The authors feel that the study should be continued over a greater number of seasons and theories further tested before reliable predictions and a sound management program can be presented.

The fact that this program has been more than self sustaining, yielding a substantial profit credited to the participating states, justifies continuance of the management study.

NOTES

SOME NEW AND UNUSUAL FISHES FROM SOUTHERN CALIFORNIA

The following is a list of fishes whose appearance off the coast of Southern California are unusual enough to warrant a published record. This list includes specimens received at the California State Fisheries Laboratory since those reported by Fitch, in "California Fish and Game," Vol. 33, No. 3, pp. 191-192, July 1947.

Icticus ischanus (Jordan and Thompson) Blackrag

An 18-inch blackrag was taken in a bait net haul near the Newport Beach Pier, Orange County, on September 23, 1946. Mr. Emery S. (Casey) Jones, skipper of the baitboat, did not recognize his catch and sent it to the California State Fisheries Laboratory for identification. Until the specimen was examined by Dr. Carl L. Hubbs of the Scripps Institution of Oceanography at La Jolla, California, and Mr. Wilbur I. Follett of the California Academy of Sciences, San Francisco, identification was not positive. This is the second known specimen of *Icticus ischanus*. The first was taken at Okinawa in 1911 and reported by Jordan and Thompson in Mem. Carnegie Mus., 6 (4), 1914; 242-243, pl. 27, fig. 4. Hubbs and Follett will publish on the present specimen in detail at some future date. The crew of the boat which caught this fish stated that as it lay on the deck, it went through color changes comparable to those noticed in a dolphin when removed from the water. The final change was to an overall dull black which remained in death.

Nautichthys oculo-fasciatus (Girard) Sculpin

A small sculpin of this species was taken on hook and line September 14, 1947, off Point Sal, San Luis Obispo County, by Mr. Earl Farris of

FIGURE 50. Monterey Spanish Mackerel, *Scomberomorus concolor*. Photograph by Al Johns for Haden and Carpenter, San Pedro

the sport fishing boat "Alaskan," operating out of Avila. Bolin states (A review of the marine cottid fishes of California, Stanford Ichthyological Bulletin, Vol. 3, No. 1, pp. 102-104, fig. 40, October, 1944) "The species ranges from about Sitka, Alaska to Monterey Bay, California . . . although common in Puget Sound, this fish is rarely taken in California." The specimen recorded here represents, therefore, a southern extension of the known range by approximately 125 miles.

Scomberomorus concolor (Lockington) Monterey Spanish Mackerel

A specimen nearly two feet in length was taken in a bait net on September 16, 1947, by the fishing boat "Manhattan," one-half mile east of the Redondo Breakwater in Santa Monica Bay. Mr. R. C. Wilson of the California State Fisheries Laboratory, who was aboard the baitboat at the time, and brought the fish to the laboratory, said it looked like a large bonito swimming in the net and not until it was removed from the net did he realize it was anything unusual. The Monterey spanish mackerel is nearly identical in appearance to the sierra of the Mexican Coast. However, the numerous gold spots on the sides of the sierra are usually enough to differentiate the two species. *Scomberomorus concolor* was fairly abundant each fall in Monterey Bay, in the 1870's and 1880's, where it became an important commercial fish. Around 1890, it failed to return in the fall and no fish of this species was taken until nearly 40 years later, when one was recorded from a San Pedro fish market in 1927. Since 1927, two were landed at Monterey in 1931, one at Long Beach in 1937, and another in 1939. The most recent specimen is therefore the sixth recorded since they disappeared nearly 60 years ago. Apparently, somewhere in the Pacific Ocean, there is enough of a stock of these fish to keep the species in existence. It has been previously reported in "California Fish and Game," by the following authors: Roedel, Vol. 25, p. 343, 1939; Croker, Vol. 23, pp. 245-246, 1937; Phillips, Vol. 18, p. 99, 1932; and Starks, Vol. 4, p. 121, 1918.

FIGURE 51. Thread Herring, *Opisthonema libertate*. Photograph by Al Johns for Vernon M. Haden, San Pedro

Opisthonema libertate (Gunther) Thread Herring

Several thread herring have been taken in bait nets throughout the year. The most recent instance was one specimen caught just outside the

San Pedro breakwater in February, 1948. This interesting fish is a member of the herring family (Clupeidae) and schools of them are numerous from the region of Magdalena Bay, Lower California, southward at least to Panama. In the region of the Gulf of California, great schools of thread herring are present and they are sometimes used as bait by the tuna boats, some of which do not empty their bait tanks until they near their home port of San Diego or San Pedro. This fact has been offered as a plausible explanation of the occurrence of this species so far from its home range. However, it is possible that a few fish do stray as far north as Southern California.

***Typhlogobius californiensis* (Steindachner) Blind Goby**

Not only was the method of capture of these specimens unique, but the northern range of the species was extended by nearly a hundred miles. They were taken in considerably deeper water than any previously recorded, and the gobies themselves were all a great deal larger than those usually collected.

In a routine check of an area after detonation of a 40-pound charge of explosives just off the western tip of Santa Cruz Island on February 16, 1948, numerous blind gobies were left floating on the surface of the water. Gulls picked up most of these but nine specimens were salvaged for later examination and identification. These gobies were all approximately three inches in length and quite heavy bodied. As is typical of this species, they were scaleless and had an overall pinkish color in life. The eyes of the adults of this form are rudimentary.

Previously *Typhlogobius californiensis* has been collected only in the zone exposed by low tides in rocky areas of our coast. It usually lives in holes in these rocks in company with the ghost shrimp, *Callianassa*. Those picked up off Santa Cruz Island were in water that varied from 15 to 25 feet in depth and presumably would have been more or less exposed since they were affected by the blast. Previous recorded range of this species was from Cedros Island, Lower California to Point Vincente near San Pedro, California.—*John E. Fitch, Bureau of Marine Fisheries, California Division of Fish and Game, March, 1948.*

HERMAPHRODITISM IN CHINESE RING-NECKED PHEASANT

Male secondary sexual characteristics have been known to occur in the female pheasant *Phasianus colchicus*. Variations in these birds range from a suggestion of the white collar to an almost complete duplication of male plumage with a dark greenish, black head, red side of head, white collar, grey-green saddle, and dark brown body feathers. Rudimentary spurs have been noted. However, the tail feathers are shorter, and the general structure of the birds are typical of the smaller female. Internal examination of such individuals reveals ovaries that are atrophied.

During the past pheasant season opportunity was afforded the author to examine many of the pheasants taken by hunters. Among the birds autopsied one small pheasant possessed plumage more completely characteristic of a male than any aberrant female that had been seen previously. Small spurs were present. The ovaries and oviduct were noted on the left side. Anterior to the ovaries were the ellipsoidal testes, and leading from them were the bilateral vas deferens.

This apparent hermaphrodite had an abundance of body fat and its ovaries were not atrophied. Although visual inspection of the body cavity and internal organs was permitted, opportunity to collect the gonads for further study was not possible.—*Merton N. Rosen; Bureau of Game Conservation; California Division of Fish and Game; March, 1947.*

RESIGNATION OF COMMISSION PRESIDENT, H. H. ARNOLD

RESOLUTION

WHEREAS, For the past two years General H. H. Arnold has faithfully served the public, the State of California and the Fish and Game Commission as an honored member and president; and

WHEREAS, The principles of conservation and preservation of California fish and game, and the public's interest therein, have been stimulated and enhanced during General Arnold's term of office; and

WHEREAS, This commission desires to express to General Arnold its appreciation and thanks for his inspirational effort and continuing guidance in its behalf and in behalf of the conservation of wildlife in California, and also desires to acquaint the public at large and the Governor of this State of such expression; now, therefore, be it

Resolved, by the Fish and Game Commission of the State of California, in regular meeting assembled, That its regret to expressed to General Arnold for the necessity of tendering his resignation; and further

Resolved, That its thanks and appreciation be and hereby are expressed publicly to General H. H. Arnold for his interest, time, and effort during the past two years in behalf of this commission as an honored member and president; and further

Resolved, That copies of this resolution be forwarded to the Governor of the State of California and to General H. H. Arnold, and that additional copies hereof be released to the press and published in all magazines and journals published by this commission. *Adopted April 30, 1948.*

APPOINTMENT OF COMMISSIONER E. L. CARTY

Edwin L. Carty, Mayor of Oxnard, was appointed to the Fish and Game Commission by Governor Warren to fill the unexpired term of General H. H. Arnold who resigned on account of ill health. Mr. Carty formerly served a full term as commissioner, being appointed by Governor Olson, to the first five-man commission created by vote of the people. Sportsmen and personnel will remember Mr. Carty for the building of the Fillmore Hatchery, as well as his other efforts for better hunting and fishing in California.

RESIGNATION OF EMIL J. N. OTT, JR., AS EXECUTIVE OFFICER

The resignation of Emil J. N. Ott, Jr., Executive Officer, effective April 30th, was accepted by the commission with regrets and an expression of goodwill in whatever enterprise with which he becomes associated. Mr. Ott had official capacity with the division for about three and a half years and was very energetic in all his endeavors.

APPOINTMENT OF E. L. MACAULAY AS EXECUTIVE OFFICER

Effective May 11th, E. L. Macaulay became the Executive Officer of the division. Prior to the appointment Mr. Macaulay had been Chief, Bureau of Patrol, for 19 years. He served in the U. S. Army during both world wars with credit to himself and his branch of the service.

REPORTS

FISH CASES

January, February, March, 1948

Offense	Number arrests	Fines	Jail sentences (days)
Abalone: Undersize, overlimit, no license, possession, closed season, failure to show license, out of shell	124	$2,917 00	30½
Angling: Use of another's license, no license, transfer of license, set lines, closed season, failure to show license, spear within 300 feet of stream, use of explosives, operating wire fish trap, nonresident using resident license, false statement to secure license	255	5,062 00	41½
Bass: Late and early fishing, more than one line, undersize, seining, night fishing, no license, other than angling	61	1,266 00	----------
Bluegill: Closed season	6	82 00	----------
Catfish: Seining, selling undersize, undersize, night fishing	6	55 00	----------
Clams: Transfer of license, undersize, night clamming, out of shell, illegal hours, no license	200	4,813 00	----------
Crabs: Undersize	3	75 00	----------
Crappie: Closed season, seining	8	150 00	----------
Cockles: Over limit, no license	33	665 00	----------
Commercial: No license, wastage of fish, failure to render reports, buying without giving receipt, failure to show license on demand	35	810 00	----------
Lobsters: Undersize, illegal use of traps, oversize, no boat registration	18	970 00	----------
Pollution: Oil, sawdust, edgings, tannic acid, fish refuse	19	2,225 00	----------
Salmon: Spearing in spawning area, snagging	2	40 00	----------
Sunfish: Closed season, netting	4	92 50	----------
Trout: Closed season, possession spear, night fishing, over limit, other than angling, snagging, more than one rod, no license	15	365 00	----------
Mackerel sardines: Delivering and receiving undersize	25	190 00	----------
Court forfeitures: Undersize mackerel and sardines	----------	6,412 00	----------
Totals	980	$26,189 50	72

GAME CASES

January, February, March, 1948

Offense	Number arrests	Fines	Jail sentences (days)
Coots: Closed season, no license, shooting from car	17	$385 00	----------
Deer: Possession doe, closed season, possession spike buck, spotlighting	50	8,413 00	526
Deer meat: Possession closed season	27	3,325 00	120
Deer tags: Failure to validate	5	50 00	----------
Doves: Closed season, unplugged gun, over limit	19	443 00	----------
Ducks: Early and late shooting, over limit, shooting from power boat, no stamp, rifle, closed season, possession for sale	221	9,435 00	30
Frogs: Closed season	1	25 00	----------
Geese: Late shooting, over limit, closed season, using live decoy, selling	34	835 00	----------
Hunting: Unplugged gun, early and late shooting, no license, transfering license, night hunting, spotlighting, failure to show license on demand, no alien license	346	4,919 00	14½
Non game: Killing robins, meadow larks, thrush	10	325 00	----------
Pheasants: Possession hen, closed season, rifle, over limit	40	2,555 00	----------
Pigeons: No license, over limit, closed season, taking homing pigeon	7	160 00	----------
Quail: Unplugged gun, over limit	13	350 00	----------
Rabbits: Closed season, night hunting	39	873 00	----------
Shore birds: Possession seagulls, killdeer	5	120 00	----------
Swans: Possession, killing, attempt to take	17	655 00	----------
Trespass: Water fowl management area	19	380 00	----------
Trapping: Removing animals from State trapper's trap	3	120 00	----------
Elk meat: Possession closed season	1	50 00	-
Totals	874	$33,418 00	690½

SEIZURES OF FISH AND GAME

January, February, March, 1948

Fish:	
Abalones	1,354
Abalones, pounds	2,060
Striped bass	30
Black bass	4
Carp	7
Catfish	49
Catfish, pounds	19
Crab	42
Crappie	10
Cockles	10,045
Clams	4,821
Bluegill	11
Bluegill, pounds	30
Lobsters	50
Lobsters, pounds	1,195
Salmon	2
Skipjack, pounds	7,680
Trout	26
Trout, pounds	20
Mackerel and sardines	512,425
Game:	
Coots	13
Deer	20
Deer meat, pounds	602
Doves	10
Ducks	623
Frogs	14
Geese	52
Non game	22
Pheasants	41
Pigeons	2
Quail	4
Rabbits	20
Shore birds	17
Swans	12

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